Building Research Establishment Digest

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Noise abatement zones: Part 2

Measuring the noise

The methods of measuring and calculating noise levels for entry in the noise level register, and requirements as to the way the register should be kept, are set out in the Regulations. Variations from the methods require the consent of the Secretary of State.

The objective is to record the typical noise output of the premises in the longer term, so measurements should be made when activity is as near normal as possible. If, however, this would mean an unacceptable delay because the plant is running below capacity for a long period, the prevailing noise may be registered but accompanied by a statement that working is below full capacity. If the propagated noise varies between summer and winter because the factory doors and windows are opened in summer to increase ventilation, measurements should be made with the doors and windows open.

The basis of all noise levels recorded in the register (other than additional maxima or peak levels) should be the equivalent continuous noise level (L_{eq}) measured in dB(A) over a stated period of time. L_{eq} is defined as the level of continuous noise over a given period which has an energy content equal to that of the actual noise (whether constant or variable) during the same period; it is given by the equation:

$$L_{eq} = 10 \log_{10} \frac{1}{T} \int_0^T \left[\frac{p_A(t)}{po} \right]^2 dt$$

where T is the time period for which L_{eq} is required,
$p_A(t)$ is the instantaneous A-weighted sound pressure in N/m^2 varying with time t, po is the reference sound pressure whose value is 20×10^{-6} N/m^2.

If the actual noise is steady throughout any period, its measured level without correction will be the L_{eq} for that period. When noise levels vary considerably over a time period, the maximum level should be recorded in addition to the L_{eq}. Any special characteristics of the noise (such as pure tones or impulses) should be noted, and distinctive activity character (eg riveting) pertinent to noise control should also be recorded. The general aim should be to record L_{eq} for the whole daytime working period (though supplemented if necessary by L_{eq} for long permanent sub-periods markedly different in level) together with prominent maxima. Night working and weekend working should be separately recorded.

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Technical enquiries arising from this Digest should be directed to Building Research Advisory Service at the above address.

The characteristics of noise

The simplest condition is a fairly steady continuous noise throughout a regular weekday working period. This can be sampled over a typical short period. If, however, the noise is periodically irregular but follows the same pattern daily, the time period at each significantly different level should be carefully observed during a typical working day, the levels then being measured and their percentage on-times noted.

An example is shown diagrammatically in Fig 5 for a factory having a 10-hour working period (0700–1700 hours) with a continuous minimum noise level, A, of 60 dB(A), rising to level B, 65 dB(A), for two half-hour periods and to level C, 75 dB(A), for a further half-hour period. Assuming that both periods at level B arise from the same noise sources, three measurement samples of sufficent duration (say 30 seconds, but this depends on the fluctuation) will be required at each of the planned measuring points. It is not expected that levels A, B, C etc will normally be entered separately in the noise level register (although this could be done for more rigorous control) but that they should be proportionally adjusted according to their duration periods and combined into one level at each point. The correction to be made to each measured level is given in Fig 6 as a function of its on-time as a percentage of the whole time period. In the example shown in Fig 5 the duration of the noise levels A, B and C is 8.5, 1 and 0.5 hours respectively and these durations represent 85, 10 and 5 per cent of the whole period of 10 hours. Using Fig 6, the correction to level A is —1 dB(A) leading to 59 dB(A) as the level which, if present for 100 per cent of the time, would be equivalent in sound energy to 60 dB(A) for 85 per cent of the time. Similarly, the correction to level B is —10 dB(A) giving 55 dB(A) and the correction to level C is —13 dB(A) giving 62 dB(A). Adding these new levels together by means of the standard graph in Fig 7 (one pair first and the resultant paired with the third level) a combined level of 64.3 dB(A) is obtained. This level would be recorded as the equivalent continuous noise level L_{eq} for the whole 10-hour period at that point, supplemented by a note that the maximum level was 75 dB(A) for half an hour.

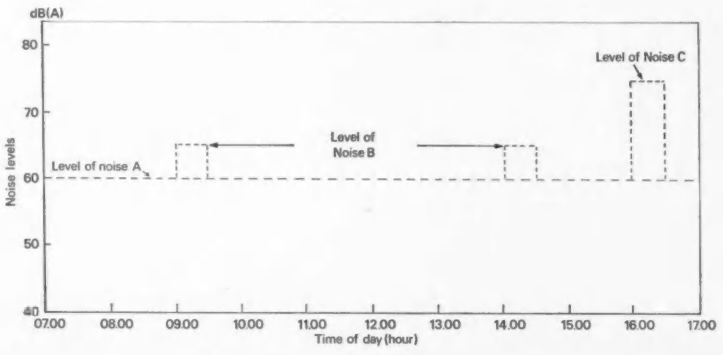

Fig 5 Example of variation of noise level with time

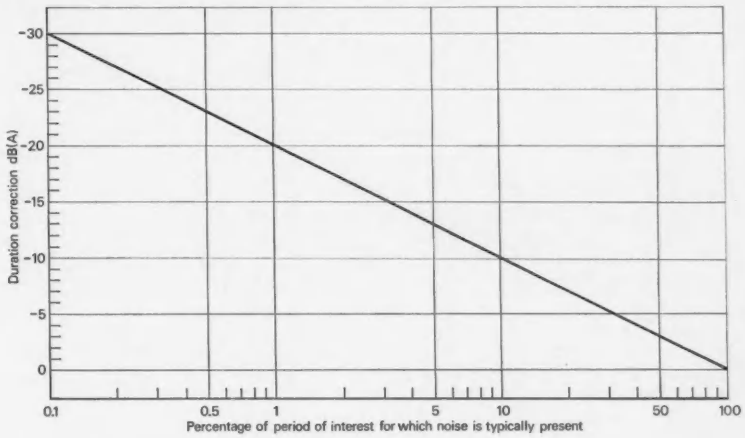

Fig 6 Correction to noise level for percentage duration

Background noise

Noise levels at points along a noise control boundary are intended as a record of the noise emanating from the premises alone, but the presence of extraneous or background noise may interfere with direct measurements of premises noise. It is hardly practicable to turn off the background noise at will, though it may be possible to choose measuring times when the background noise is at a minimum, and this would be helpful. However, it should usually be possible to arrange for the louder noises from the premises to be stopped for a while so that the extraneous noise alone can be measured. The factory noise itself may then be calculated fairly closely from the difference between the combined and background noise levels, especially if the background is no louder than the factory noise. The calculation may be made by using the graph in Fig 8; it will be seen that when the difference between combined noise and background noise is less than 3 dB(A) the correction for obtaining the factory noise becomes much less accurate. A difference of 3 dB(A) indicates that noise levels from premises and background are equal, whilst differences of less than 3 dB(A) mean that background noise is the higher component.

In those cases where it is not possible to stop the factory noise and only the combined noise can be measured, an aural judgement will have to be made of the relative loudness of the two components and an arbitrary method of calculation used to assess the noise contribution from the premises. A note in the register should state that the recorded level is derived from a calculation procedure. The calculation is based on the following table, which shows the amount to be deducted from the measured L_{eq} of the combined noise (from premises and background) to find the output from the premises:—

when the premises noise is clearly louder than the extraneous noise . . . . . deduct 0 dB(A)
when the extraneous noise dominates the premises noise but sounds less than twice as loud . . . . . deduct 3 dB(A)
when the extraneous noise is recognisably at least twice as loud as noise from the premises . . . . . deduct 6 dB(A)

The calculation procedure will be less precise than measurements but the calculated level will tend to be an over-estimate of the level from the premises and thus it is very unlikely that a level will be registered which is below that actually produced.

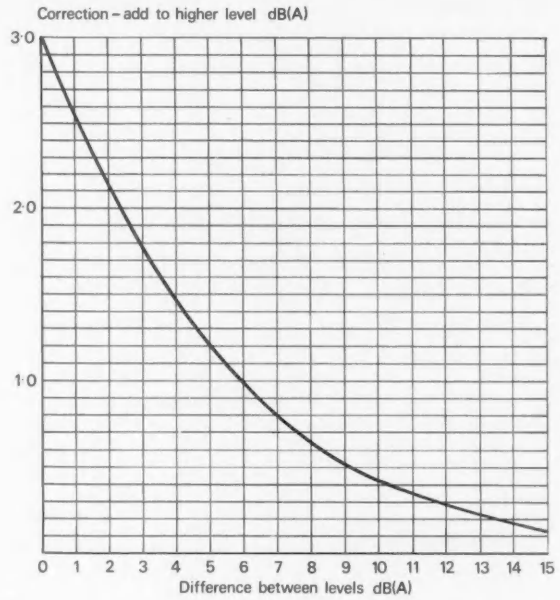

Fig 7 Summing noise levels

Meteorological conditions

Weather can have a marked effect on noise measurements, especially at long distances and when source or receiver is close to the ground. Adverse conditions such as high wind, snow, rain, fog and temperature inversion (which is often associated with calm, clear nights, sometimes with a tendency to the formation of mist or fog) should be avoided as far as possible. Frost alone will not affect measurements.

Finding suitable wind conditions poses the greatest problem. Moderate winds in any direction are acceptable for measuring at distances up to 25 m from the source. For distances between 25 and 50 m, either calm or a positive wind speed up to 2 m/sec from the source towards the measuring point is preferred. At distances greater than 50 m, wind conditions are more critical and a positive wind speed of 1 to 2 m/sec from the source towards the measuring position is desirable, as this ensures that the level of noise from the source reaching the microphone is a little above average but not excessively so. This means that in future any measured increases in level are unlikely to be due to wind effects. Wind conditions for measuring background noise are less critical because the noise will usually be less directional, but very strong winds should be avoided.

Wind can itself create noise at the microphone which may not always be overcome by a microphone windshield and will be unacceptable if it rises to within 10 db(A) of the noise to be measured. In cases of doubt a check should be made in a quiet situation exposed to a similar wind.

Measuring equipment

The Regulations specify the type of equipment which can be used for noise measurements under various conditions. All measuring equipment should conform to the relevant standards set out below and be properly maintained and calibrated to an accuracy of ± 0.5 dB. A microphone windshield of a type that does not affect calibration appreciably should be used for all measurements.

For steady noise A sound level meter conforming to BS4197[6] may be used; it should incorporate A-weighting and be set at the SLOW dynamic characteristic. Noise is deemed steady for this purpose if fluctuations of the meter reading do not exceed ± 4 dB(A). Having determined by prolonged observations that the sound level to be measured varies by no more than ± 4 dB(A), the sound level averaged visually over a short period (30 to 60 sec) may be taken as numerically equal to L_{eq} for the period of interest.

The same meter can be used for noise levels which change at times but remain steady throughout the periods between the changes, each period being separately measured and its duration or on-time noted.

For variable noise The sound level meter mentioned above for steady noise is not suitable on its own for measuring noise that is continually variable in level, with little or no distinguishable steady noise. Either of the following two methods (a) or (b) may be used unless there are impulsive noise components present when only method (b) is permissible.

(a) The first of these requires equipment providing a statistical analysis of the sound levels and registering L_{eq} on the basis of the formula given below. The equipment should have an overall acoustic performance similar to that of the sound level meter specified earlier. For this method a choice can be made between two sets of equipment:

(i) a microphone, a microphone amplifier, a graphic sound level recorder (producing a graphic record of the noise level being measured) and a statistical analyser.

(ii) data-logging equipment which samples the noise level (by periodic measurements) and produces an output in digital form on magnetic tape, which is then replayed through a suitably programmed calculator to give L_{eq}.

For analysis using equipment (i) or (ii) the varying sound levels must be sorted into bands of 5 dB(A) or less according to the range of noise levels to be covered and the accuracy of the analysis required. The summed time duration in which the sound level lies within any particular band should be recorded and converted to a percentage of the whole period. The final analysis to give L_{eq} in dB(A) for the whole registered period is then obtained from the following formula:

L_{eq} (whole period) =

$$10 \log_{10} \left[\frac{1}{100} \left(f_1 10^{L_1/10} + f_2 10^{L_2/10} \ldots\ldots + f_n 10^{L_n/10} \right) \right]$$

where $L_{1,2,3\ etc}$ is the respective centre-point level of each dB(A) band-interval; $f_{1,2,3\ etc}$ is the percentage of the time during which the sound level lies within each band-interval corresponding to $L_{1,2,3\ etc}$; and n is the total number of dB(A) band-intervals covering the range of noise levels.

(b) The second method which may be used for continually variable noise levels is particularly appropriate for rapidly fluctuating levels, especially over a wide range, and is essential when the noise contains impulsive elements; the method requires an integrating meter, ie one giving a direct reading of L_{eq}. The meter should incorporate an A-weighting network in the circuit and should be designed to give a value of L_{eq} in dB(A) according to the equation from which L_{eq} is derived (see page 1).

The integrating meter should meet all the relevant requirements of BS4197. A dynamic range of at least 60 db(A) is necessary when the instrument is required to measure impulsive noise. The instrument should incorporate an instantaneous overload indicator to show whether the noise level being measured has exceeded the maximum level the meter is capable of measuring.

It is suggested in SI No 37 [2] that measurements of L_{eq} for impulsive noise should be supplemented by measurements of maximum level. To measure maximum levels of impulsive noise the equipment should also comply with BS 4197 and should be set to FAST response.

Monitoring

A noise level register implies some degree of monitoring but in general this should not be necessary at every point at which the original noise measurements were taken and registered. Monitoring becomes necessary where there is reason to believe that the noise output has been increased, perhaps already having given rise to complaints, or when it is known that a new noise source has been introduced. Monitoring checks should be made with equipment similar to that used originally, in weather similar to that prevailing at the time of the registered measurements. Checks may be limited initially to key measuring points only, possibly proceeding to a full check survey if there is sufficient evidence that an offence under the Act has been committed.

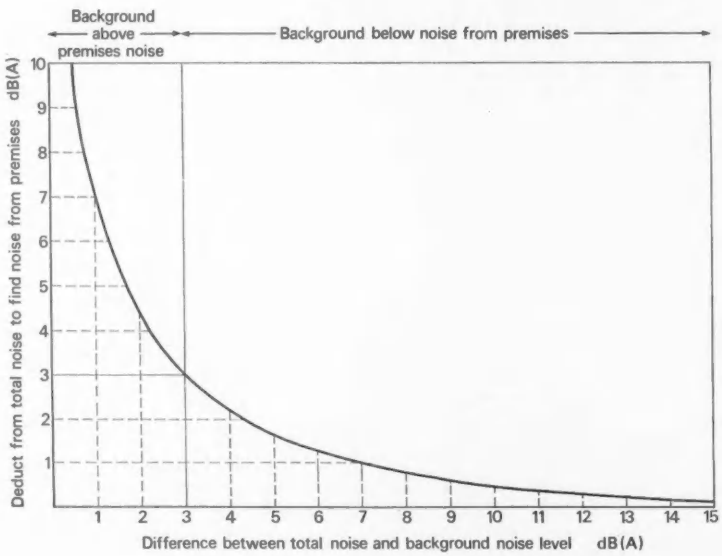

Fig 8 Correcting total noise to find component noise when other component is known

Noise reduction notices

When monitoring shows that the registered levels are being exceeded, a noise reduction notice should be served on the premises. Such notices may also be served if the local authority considers that an abatement of the registered noise output is possible at reasonable cost and in the interests of the community. In the latter case preliminary consultation with the management of the premises is recommended to engender a spirit of co-operation. The stipulated reduction in noise level may be confined to particular noise sources or to particular periods and would come into effect at a specified date not less than six months ahead. A further case for serving noise reduction notices arises when new buildings or other works which constitute classified premises are erected in a noise abatement zone and the noise emitted is found to exceed acceptable levels determined by the local authority under powers conferred by the Act. In this case the specified date for compliance need not be more than three months ahead, and the condition as to reasonable cost will not apply; nor is it a defence to claim that the best practical means to abate the noise have been employed.

Applications to exceed registered levels

The registered levels may not be exceeded without consent, but this is not intended to establish a bias against consent in all cases. Two cases in particular should be sympathetically considered. The first arises when the noise output from the premises was registered during a period of reduced working capacity, with a subsequent return to full capacity. The second case applies to certain measuring points on the control boundary and may arise when the management wishes to increase noise, perhaps due to re-location of plant, only in a direction relatively insensitive to noise (eg areas already highly industrialised or perhaps unpopulated for the foreseeable future) without any significant increase and possibly with a reduction in more sensitive directions. It should be borne in mind that other benefits, such as employment prospects, may be involved. Consultations with other departments, such as employment, health and planning, may well be called for in such cases and will be essential in all cases of new development. New development will of course involve the pre-setting of maximum boundary noise levels to be checked and registered when the premises come into full operation.

Appeals

The Act provides for appeals under Sections 64–67, as follows:—

(a) against an entry in a noise level register: within 28 days;
(b) against a refusal to allow a registered noise level to be exceeded: within three months;
(c) against a noise reduction notice: within three months;
(d) against a determination of noise levels from a new or modified building: within three months.

An appeal under (c) lies to a magistrates' court. In the other three cases an appeal lies to the Secretary of State. In court proceedings under (c) it is a defence to prove that the best practical means to control the noise have been adopted, but this defence is not permissible in proceedings instituted under (d).

Particulars of all consents, notices, appeals and decisions must be recorded by the local authority in the noise level register.

References and further reading (see also Part 1)

1 Control of Pollution Act 1974, Part III, Noise; HMSO
2 The Control of Noise (Measurement Registers) Regulations 1976, SI No 37; HMSO
3 The Control of Noise (Appeals) Regulations 1976, SI No 2116; HMSO
4 Control of Pollution Act 1974. Implementation of Part 3—Noise; DoE Circular 2/76; HMSO
5 BS 4142:1967 Method of rating industrial noise affecting mixed residential and industrial areas; British Standards Institution
6 BS 4197:1967 A precision sound level meter; British Standards Institution.

Noise levels at the boundaries of factories and commercial premises; BRE Current Paper CP 43/76

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